de maximis, inc.

186 Center Street
Suite 290
Clinton, NJ 08809
(908) 735-9315
(908) 735-2132 FAX

February 19, 2014

Mr. Ray Basso
U.S. Environmental Protection Agency, Region II
290 Broadway
New York, New York 10007-1866

Via Electronic Mail

Re: *Summary of the Principal Reason That EPA and CPG Predict Different Residual Risk Estimates for a Targeted Remedy*

Dear Mr. Basso:

The Lower Passaic River Study Area Cooperating Parties Group (CPG) appreciates the opportunity to discuss the CPG's bioaccumulation model and residual risk estimates during the February 13, 2014 web-meeting. At the conclusion of this web-meeting, you asked the CPG to address your question of why the CPG predicts that the Sustainable Remedy achieves residual risk lower than 10^{-4} (within EPA's target risk range) when its fate and transport model predicts a post-remedy average 2,3,7,8-TCDD concentration in the top 15 cm of sediment that exceeds 100 ppt. The purpose of this letter is to respond to your question.

A primary factor in the calculation of residual risk is the sediment concentration used as the input (i.e., exposure point concentration) for either the bioaccumulation model or the BSAF calculation. The CPG does not use the average 2,3,7,8-TCDD concentration from the top 15 cm of sediment to calculate fish tissue concentrations as a default value in its bioaccumulation model. Instead, the CPG uses 2,3,7,8-TCDD concentrations of near-bottom sediments suspended in the water column and the top 2 cm of bed sediment as an exposure zone to determine the exposure point concentrations for the bioaccumulation model. Please bear in mind that the CPG's fate and transport model predicts much lower concentrations in the near-bottom suspended sediment and top 2 cm than the average concentration in the top 15 cm of sediment. This difference in determining the exposure point concentration is the answer to your question; however, the more important issue is the justification for using the near-bottom suspended sediments and top 2 cm as an exposure zone.

EPA guidance expresses a preference for using site-specific data. See RAGS, Part A[1] ("*Although default values for some modeling parameters are available, it is preferable to obtain site-specific values for as many input parameters as is feasible*").

The LPRSA RI data collected by both EPA and CPG demonstrate that most benthic organisms inhabit and feed in the near-bottom suspended sediments and the top 2 cm. The use of these site-specific data is consistent with EPA guidance[2]. Furthermore, the use of site-specific data to define a surficial exposure zone for bioaccumulation modeling is consistent with modeling employed at other Region 2 sites such as the Grasse River and Hudson River. The details of how this difference affects predictions of residual risk are presented below.

[1] Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part A) at 4-5 (EPA 1989).
[2] See FN 1; see also USEPA, Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final, OSWER 9285.7-25.

employed at other Region 2 sites such as the Grasse River and Hudson River. The details of how this difference affects predictions of residual risk are presented below.

- The LPRSA's exposure zone (2 cm) is governed by conditions within the LPR such as organic content, dissolved oxygen concentrations, salinity and physical disturbance. The conditions that restrict the exposure zone to the upper two centimeters will be reestablished once remediation activities have been completed. Therefore, it should be expected that a thin exposure zone will continue to be a characteristic of the LPR post-remediation, and other feasible watershed improvements are unlikely to result in a deeper biologically active zone.

- LPRSA-specific data demonstrate that the types of organisms that inhabit the LPR feed on sediment within the top 2 cm and on near-bottom suspended sediment. These biological data include:
  - benthic ecology community surveys conducted as part of the LPRSA RI by the CPG and;
  - photography and analyses of the LPR sediments (Sediment Profile Imaging or SPI) conducted by EPA for the LPRSA RI.

  The benthic community survey data identify specific species and taxa that inhabit the LPRSA sediment; conclusions on the thickness of the exposure zone and its interaction with near bottom suspended solids are based on the knowledge of the organisms' life habits and feeding strategies. The 2005 SPI report confirms the findings that these organisms inhabit this layer.

- The difference in fish tissue concentration principally derives from differences in the assumption about what sediments the organisms at the bottom of the food chain are exposed to.
  - EPA uses a default assumption that organisms are exposed to the entire top 15 cm of the sediment bed. That assumption is <u>not</u> supported by LPRSA RI data.
  - The CPG's food web bioaccumulation model uses LPRSA RI data and incorporates the fact that organisms are living in the top 2 cm of surface sediment and are only exposed to that portion of the sediment bed as well as near-bottom suspended sediment. This formulation is consistent with the 2006 LPRRP Final Modeling Work Plan[3] which states *"benthic invertebrates obtain contaminant through the ingestion of contaminated sediment particles and/or from phytoplankton and detrital matter at the sediment -water interface"*. The CPG's bioaccumulation model predicts lower fish tissue concentrations, which in turn results in lower residual risk.

The CPG is confident in its modeling which uses the top 2 cm of sediment bed and near-bottom suspended solids to determine the exposure point concentration because it is based on LPRSA RI

[3] See Section 6.3 and Figure 6-7

data. The use of a site-specific exposure zone is consistent with bioaccumulation modeling at other Region 2 sediment sites (e.g., Grasse and Hudson Rivers) and that an exposure zone developed using multiple lines of evidence using site-specific data should take precedence over default assumptions to identify an exposure zone pursuant to EPA guidance.

The CPG anticipates more meetings and interactions with EPA and its consultants to further the development of the bioaccumulation model. The CPG looks forward to the opportunity to continue its discussions with EPA on it as well as the CPG's Sustainable Remedy.

The CPG has included additional supporting information as an attachment and is ready to address any other questions or provide additional information that EPA requires.

Please contact me if you have further questions or require additional information.

Very truly yours,
de maximis, inc.

Robert Law, Ph.D.
CPG Project Coordinator

cc: Walter Mugdan, EPA Region 2
Stephanie Vaughn, EPA Region 2
Jennifer LaPoma, EPA Region 2
James Woolford, EPA HQ
Steve Ells, EPA HQ
Marc Greenberg, EPA HQ
CPG Members
William Hyatt, CPG Coordinating Counsel
Willard Potter, *de maximis, inc.*

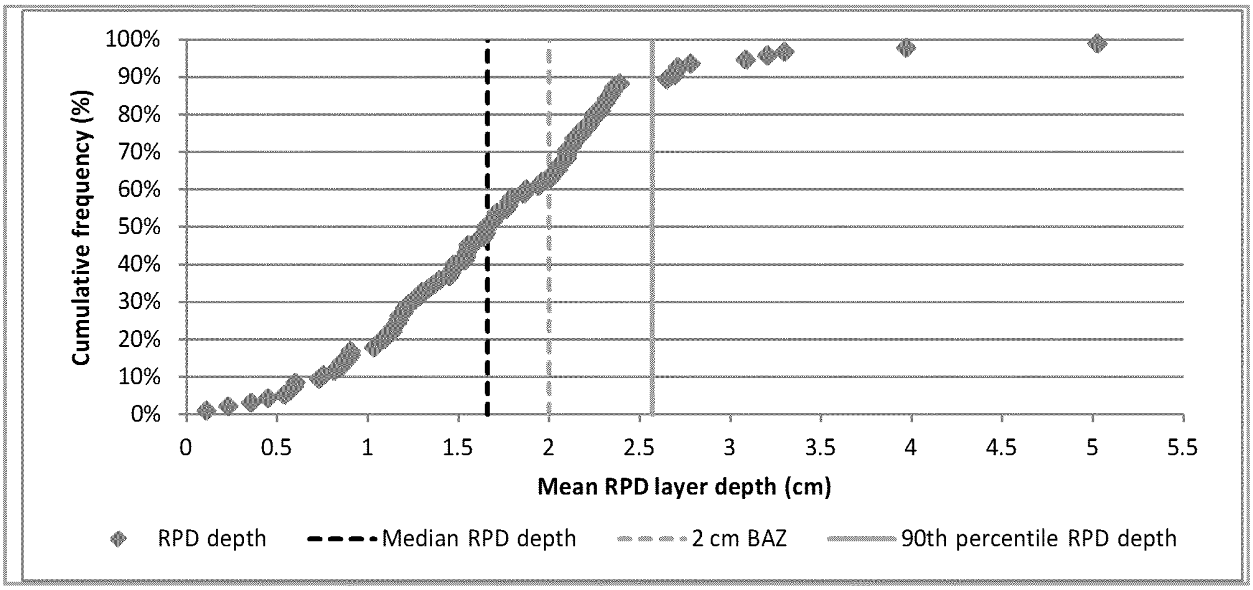
Attachment

Attachment - Summary of Benthic Ecology Evidence that Supports a 2 cm Sediment Interval for Risk Estimates

The current Lower Passaic River Study Area (LPRSA) benthic invertebrate community is concentrated in the upper 2 cm of bedded sediment (considered the biologically active zone) where benthic organisms are actively re-working the sediment and where exposure to sediment associated chemicals occurs. It is concluded from the following lines of evidence (LOEs) collected as part of the LPRSA remedial investigation/ feasibility study (RI/ FS) that the benthic community is found in the upper 2 cm:

- Based on the Sediment Profile Imaging (SPI) survey conducted in the LPRSA by Germano and Associates (2005), the mean redox potential discontinuity (RPD) depth in the brackish water sections of the LPRSA was 1.6 cm, while the mean RPD depth in the freshwater sections was 1.9 cm. Figure 1 shows the sitewide (i.e,. RM 0 to ~RM 16) distribution of RPD depths measured during that study. The RPD depth is the boundary between oxygenated and anoxic sediment, which in sediment can be as little as a few millimeters (Vermeij 1987, Germano and Associates 2005), and it is dependent principally upon biological activity and physical mixing.
- Consistent with the RPD depth, Germano and Associates (2005) found that most of the biological activity in the LPRSA was occurring in the aerobic zone, i.e., within the top 2 cm, and that feeding voids observed in deeper sediment were infrequently observed (approximately 24% of SPI locations with penetration depths > 2 cm and only a few were > 4 cm).
- Using available benthic invertebrate trait data from the literature (e.g., empirical evidence of burrowing depth, body length, feeding strategy, mobility, tolerance of anoxia, and/ or other relevant life history), all benthic invertebrates observed during the CPG surveys of LPRSA benthic community during the RI, were categorized in terms of their likely burrowing depth. Based on this categorization of benthic taxa, the majority of benthic invertebrates observed in the LPRSA are typically not expected to be found at sediment depths greater than a few centimeters, particularly in transitional and freshwater zones of the LPRSA (i.e., upstream of RM 4) where benthic invertebrates were more abundant.
- Feeding strategies and organism size for the more abundant benthic invertebrates indicate that they are primarily feeding in the shallow-bedded sediment or at the sediment surface. For example, *Limnodrilus hoffmeisteri*, *L. udekemianus, Quistadrilus multisetosus*, *Aulodrilus pigueti, Hobsonia florida, Gammarus* sp., and *Corbicula* sp. are expected to be found in shallow sediment,

either feeding at the surface or near the surface[1]; those 7 species account for approximately 74% of the total abundance in the LPRSA.



Source: Germano and Associates (2005) for the LPRRP - USEPA Region 2 and Partner Agencies

Figure 1 Distribution of RPD layer depths measured during SPI survey of the LPRSA

[1] For example, tubificid worms tend to feed with their heads down in sediment, but with their tails extending above burrows; L. hoffmeisteri, a tubificid that accounted for more than 50% of the total abundance, sitewide, grows approximately 2 cm in length on average.

Summary of Biologically Active Zone (BAZ) Site Literature				
Site	**BAZ Depth**	**Analysis Tool Used**	**Ascribed Causes**	**Citation**
Sweden	Upper few cm	SPI survey	High oxygen demand from high nutrient and high organic carbon input	Nilsson, H.C, Rosenburg, R.2000.
Hudson	Upper few cm, p.5-32	literature	Natural history of FW systems	Anchor QEA. Hudson River Vol. 2 July 1999.
Grasse River	Upper few cm	Site-specific community studies, literature	Oligochaetes and chironmids upper few m in FW systems; natural history of these organisms	Alcoa, June 2012. Analysis of Alternatives Report, Grasse River Study Area, Massena, NY
Providence River and Narragansett bay, RI	Variable; multiple stations under 2-3 cm	SPI survey	Organic enrichment from CSOs and other sources	Valente, R.M et al. 1992
Embayment, west coast of Ireland	2-3 cm	SRI survey and benthic grab samples	Organic enrichment from mariculture operations	O'Connor, B.D.S. et al. 1989
Great Sound, NJ	Upper few cm	SPI survey, benthic invertebrate collection	Organic enrichment	Grizzle, R.E., and C.A. Penniman, 1991
World-wide and lab studies	Upper few cm in sediment	Measurements of redox and oxygen	Depleted oxygen and rpd layer affecting benthic organisms	Diaz, R.J and R Rosenburg 1995
Sweden	Upper few cm	Benthic community, sediment cores	Organic enrichment	Gunnarsson, J.S., K Hollertz and R Rosenburg. 1999
various	Distance from organic source	Benthic community	Organic enrichment	Pearson, TH, and R Rosenberg. 1978
Sweden	Upper few cm	Benthic community, SPI	Organic enrichment; oxygen depletion	Nilsson, HC and R Rosenberg 1997
Sweden	Upper few cm	Benthic community, oxygen, redox layer	Oxygen depletion	Nilsson, HC and R Rosenberg 1994

References

Diaz RJ, Rosenberg R. 1995. Marine benthic hypoxia: a review of its ecological effects and the behavioural responses of benthic macrofauna. Oceanogr Mar Biol 33:245-303.

Germano & Associates. 2005. Final report: sediment profile imaging survey of sediment and benthic habitat characteristics of the Lower Passaic River. Lower Passaic River Restoration Project. Germano & Associates, Inc., Bellevue, WA.

Grizzle RE, Penniman CA. 1991. Effects of organic enrichment on estuarine macrofaunal benthos: a comparison of sediment profile imaging and traditional methods. Mar Ecol Prog Ser 74:249.

Gunnarsson JS, Hollertz K, Rosenberg R. 1999. Effects of organic enrichment and burrowing activity of the polychaete *Nereis diversicolor* on the fate of tetrachlorobiphenyl in marine sediments. Environ Toxicol Chem 18(6):1149-1156.

Nilsson HC, Rosenberg R. 1994. Hypoxic response of two marine benthic communities. Mar Ecol Prog Ser 115:209-217.

Nilsson HC, Rosenberg R. 1997. Benthic habitat quality assessment of an oxygen stressed fjord by surface and sediment profile images. Marine Systems 11:249-264.

Nilsson HC, Rosenberg R. 2000. Succession in marine benthic habitats and fauna in response to oxygen deficiency: analysed by sediment profile-imaging and by grab samples. Mar Ecol Prog Ser 197:139-149.

O'Connor BDS, Costelloe J, Keegan BF, Rhoads DC. 1989. The use of REMOTS® technology in monitoring coastal enrichment resulting from mariculture. Mar Poll Bull 20(8):384-390.

Pearson TH, Rosenberg R. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanogr Mar Biol Ann Rev 16:229-311.

QEA. 1999. PCBs in the upper Hudson River. Vol 2. A model of PCB fate, transport, bioaccumulation. Prepared for General Electric, Albany, NY. Quantitative Environmental Analysis, LLC, Liverpool, NY.

Valente RM, Rhoads DC, Germano JD, Cabelli VJ. 1992. Mapping of benthic enrichment patterns in Narragansett Bay, Rhode Island. Estuaries 15(1):1-17.

Vermeij G.J. 1987. Evolution and Escalation: An Ecological History of Life. Princeton University Press.